

# LOW PHASE NOISE CLOCK MULTIPLIER

# ICS613

## Description

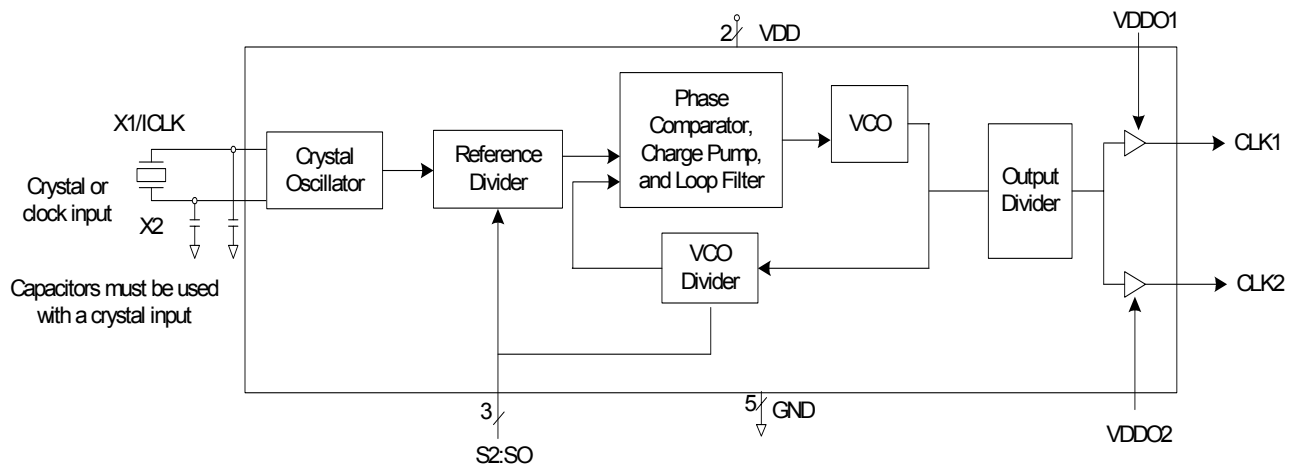
The ICS613 is a low cost, low phase noise, high performance clock synthesizer for any applications that require low phase noise and low jitter. It is IDT's lowest phase noise multiplier. Using IDT's patented analog and digital Phase Locked Loop (PLL) techniques, the chip can accept a 25 MHz crystal or clock input, and produces output clocks up to 157.5 MHz.

The chip has separate power supplies for the clock outputs, allowing each output to be run at different voltages. It also allows the core of the chip to operate at 3.3 V, while the output clocks run at either 2.5 V or 3.3 V.

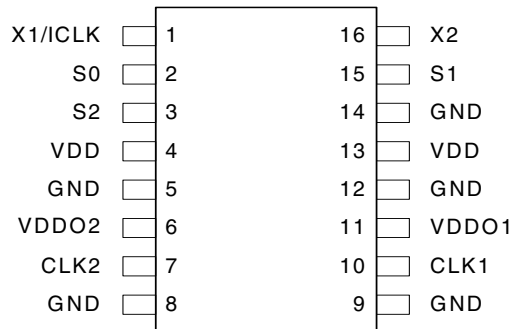
## Features

- Packaged in 16 pin SOIC
- Pb (lead) free package
- Uses a fundamental 25 MHz crystal or clock
- Operating voltage of 3.3 V
- Separate output voltage supplies which can run at 2.5 V or 3.3 V
- Output clocks up to 157.5 MHz
- Low phase noise: -110 dBc/Hz at 10 kHz
- Low jitter of 36 ps (one sigma)
- Advanced, low power, sub-micron CMOS process

## Block Diagram



## Pin Assignment



16 Pin (150 mil) SOIC

## Clock Select Table

S2	S1	S0	Input	Output (CLK1 and CLK2)
0	0	0	25	125
0	0	1	25	156.25
0	1	0	25	143.75
0	1	1	25	150
1	0	0	25	146.875
1	0	1	25	157.5
1	1	0	25	140
1	1	1	25	156.25

## Pin Descriptions

Pin Number	Pin Name	Pin Type	Pin Description
1	XI/ICLK	Input	Crystal Connection. Connect to a 25 MHz crystal or clock.
2	S0	Input	Select pin 0. Internal pull-down.
3	S2	Input	Select pin 2. Internal pull-down.
4	VDD	Power	Connect to +3.3V. Must be the same as pin 13.
5	GND	Power	Connect to ground.
6	VDDO2	Power	Output VDD for CLK2. Connect to either +2.5V or +3.3V.
7	CLK2	Output	CLK2 output. Frequency based on table above.
8	GND	Power	Connect to ground.
9	GND	Power	Connect to ground.
10	CLK1	Output	CLK1 output. Frequency based on table above.
11	VDDO1	Power	Output VDD for CLK1. Connect to either +2.5V or +3.3V.
12	GND	Power	Connect to ground.
13	VDD	Power	Connect to +3.3V. Must be the same as pin 4.
14	GND	Power	Connect to ground.
15	S1	Input	Select pin 1. Internal pull-up.
16	X2	Input	Crystal Connection. Connect to a 25 MHz crystal. Leave unconnected for clock input.

## External Component Selection

The ICS613 requires a minimum number of external components for proper operation.

### Decoupling Capacitors

Decoupling capacitors of 0.01 $\mu$ F should be connected between VDD and GND pairs on pins 4 and 5, pins 6 and 8, pins 11 and 9, and pins 13 and 14 as close to the ICS613 as possible. For optimum device performance, the decoupling capacitors should be mounted on the component side of the PCB. Avoid the use of vias in the decoupling circuit.

### Series Termination Resistor

When the PCB traces between the clock outputs and the loads are over 1 inch, series termination should be used. To series terminate a 50 $\Omega$  trace (a commonly used trace impedance) place a 33 $\Omega$  resistor in series with the clock line, as close to the clock output pin as possible. The nominal impedance of the clock output is 20 $\Omega$ .

### Crystal Tuning Load Capacitors

The device crystal connections should include pads for small capacitors from X1 to ground and from X2 to ground.

These capacitors are used to adjust the stray capacitance of the board to match the nominally required crystal load capacitance. Because load capacitance can only be increased in this trimming process, it is important to keep stray capacitance to a minimum by using very short PCB traces (and no vias) between the crystal and device. Crystal capacitors must be connected from each of the pins X1 and X2 to ground. The value (in pF) of these crystal caps should equal  $(C_L - 6\text{pF}) \times 2$ . In this equation,  $C_L$  = crystal load capacitance in pF.

Example: For a crystal with a 16 pF load capacitance, each crystal capacitor would be 20 pF  $[(16-6) \times 2 = 20]$ .

## Reducing Jitter and Phase Noise

For applications that only require one output, jitter and phase noise can be reduced by tying the unused VDDO to ground. This will stop the output clock low which will result in less switching noise on the active output.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS613. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

Item	Rating
Supply Voltage, VDD	7V
All Inputs and Outputs	-0.5V to VDD+0.5V
Ambient Operating Temperature	0 to +70° C
Storage Temperature	-65 to +150° C
Soldering Temperature	260° C

## Recommended Operation Conditions

Parameter	Min.	Typ.	Max.	Units
Ambient Operating Temperature	0	–	+70	°C
Power Supply Voltage (measured in respect to GND)	+3.15		+3.45	V

## DC Electrical Characteristics

VDD=3.3V ±5% , Ambient temperature 0 to +70° C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Voltage	VDD		3.15		3.45	V
Output Voltage	VDDO		2.375		VDD	V
Output High Voltage	V <sub>OH</sub>	I <sub>OH</sub> = -12 mA	2.4			V
Output Low Voltage	V <sub>OL</sub>	I <sub>OL</sub> = 12 mA			0.4	V
Output High Voltage (CMOS Level)	V <sub>OH</sub>	I <sub>OH</sub> = -4 mA	VDD-0.4			V
Input High Voltage (S2:S0)	V <sub>IH</sub>		2.5			V
Input Low Voltage (S2:S0)	V <sub>IL</sub>				0.5	V
Input High Voltage (ICLK)	V <sub>IH</sub>		1.7			V
Input Low Voltage (ICLK)	V <sub>IL</sub>				0.7	V
Operating Supply Current	IDD	No load		27		mA
Short Circuit Current	I <sub>OS</sub>			±50		mA

## AC Electrical Characteristics

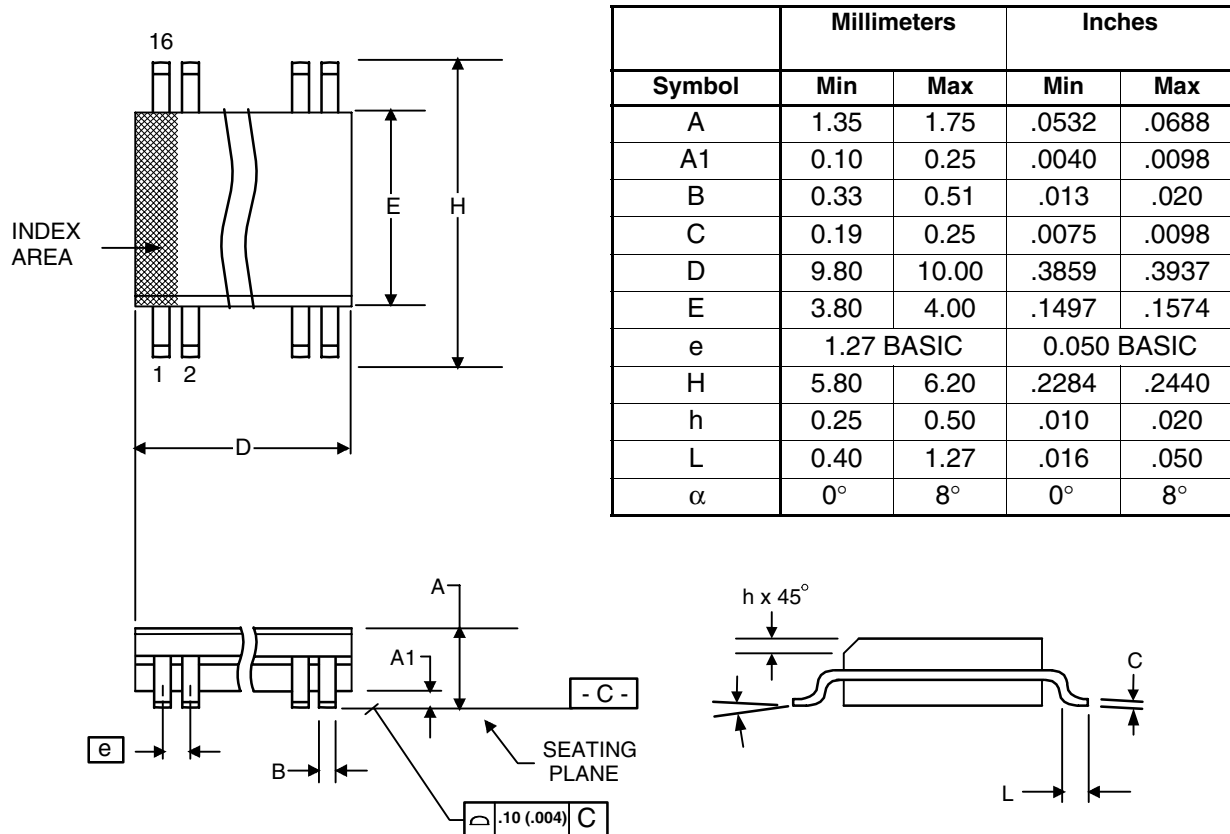
VDD = 3.3V ±5%, Ambient Temperature 0 to +70° C, unless stated otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency	f <sub>in</sub>			25		MHz
Output Frequency	f <sub>out</sub>		125		157.5	MHz
Output Rise Time	t <sub>OR</sub>	20% to 80%, C <sub>L</sub> =15 pF, VDD=3.3 V		700		ps
Output Fall Time	t <sub>OF</sub>	80% to 20%, C <sub>L</sub> =15 pF, VDD=3.3 V		700		ps
Output Rise Time	t <sub>OR</sub>	20% to 80%, C <sub>L</sub> =15 pF, VDDO's=2.5 V			1.0	ns
Output Fall Time	t <sub>OF</sub>	80% to 20%, C <sub>L</sub> =15 pF, VDDO's=2.5 V			1.0	ns

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Output Clock Duty Cycle	$t_D$	At VDDO's/2, $C_L=15$ pF	45	50	55	%
Maximum Output Jitter, short term	$t_J$	$C_L=15$ pF, 125 MHz output		$\pm 30$	$\pm 60$	ps
Maximum one sigma jitter	$t_{SJ}$	$C_L=15$ pF, 125 MHz output		8	20	ps
Phase Noise, relative to carrier, 125 MHz		100 Hz offset		-90		dBc/Hz
Phase Noise, relative to carrier, 125 MHz		1 kHz offset		-115		dBc/Hz
Phase Noise, relative to carrier, 125 MHz		10 kHz offset		-120		dBc/Hz
Phase Noise, relative to carrier, 125 MHz		100 kHz offset		-115		dBc/Hz
Skew		VDDO1=VDDO2		0	250	ps

## Package Outline and Package Dimensions (16 pin SOIC, 150 Mil. Narrow Body)

Package dimensions are kept current with JEDEC Publication No. 95



## Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
613MLF	ICS613MLF	Tubes	16 pin SOIC	0 to +70° C
613MLFT	ICS613MLF	Tape and Reel	16 pin SOIC	0 to +70° C

"LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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